CONTRACT SERIAL NUMBER: OSQ85-00107

CONTRACTOR: BECQUEREL LABS

REQUISITION NUMBER: 23440-5-9062-6

TITLE: NEUTRON ACTIVATION ANALYSIS REPORT:
FINAL REPORT;

CCRMP - CANMET

REFERENCE : OKA-2

NEUTRON ACTIVATION ANALYSIS REPORT

Received 9-Feb-86
CAS

BECQUEREL LABORATORIES INC.

6620 KITIMAT ROAD, UNIT 4
MISSISSAUGA, ONTARIO, CANADA L5N 2B8
PHONE (416) 826-3080
TELEX 06-218215

February 3, 1986

Mr. Clint Smith,
CANMET/Mineral Science Labs.,
Energy, Mines and Resources,
555 Booth St.,
Ottawa, Ontario.
K1A 0G1

Dear Clint:

Enclosed are my results on OKA-2. All results are by instrumental neutron activation analysis. This is a very difficult sample for the technique due to the unusual matrix, which generally tends to cause low results except in a few specific cases where spectral or fission interference could cause high results (for example Tm).

However, I have taken pains to get around these effects after several initial runs on the samples, and I have some confidence that this is a good data set. Please take note of the random error assessment given for each result.

Confirmation for Uranium and Thorium results come from a direct count of the samples' natural radioactivity, which further indicates that the Th-232 and U-238 decay chains are in secular equilibrium.

Sincerely yours,

Craig Stuart.

D.C. Stuart, Ph.D.

DCS/sv
encls.

CCRMP - CANMET

REFERENCE : OKA-2

NEUTRON ACTIVATION ANALYSIS REPORT

31-JAN-86

BECQUEREL LABS INC.

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NEUTRON ACTIVATION ANALYSIS REPORT — 31-JAN-86
FOR : CCRMP - CANMET
SAMPLE : OKA-2 1 — MOISTURE CONTENT = 0.3 %

ELEMENT	CONTENT	RSD, %	ELEMENT	CONTENT	RSD, %
POTASSIUM(%)	< 0.840		RARE EARTHS :		
SCANDIUM	30.6	5.6	CERIUM	1.200E+05	3.0
SODIUM (%)	0.349	5.7	DYSPROSIUM	2.640E+03	5.8
THORIUM	2.680E+04	3.0	ERBIUM	< 560.	
URANIUM	227.	16.2	EUROPIUM	2.050E+03	3.0
			GADOLINIUM	3.500E+03	33.6
			HOLMIUM	210.	6.0
			LANTHANUM	4.880E+04	3.0
			LUTETIUM	< 6.70	
			NEODYMIUM	5.450E+04	3.1
			PRASEODYMIUM	1.200E+04	8.3
			SAMARIUM	8.760E+03	3.0
			TERBIUM	498.	3.8
			THULIUM	149.	19.2
			YTTERBIUM	140.	12.5

NOTES :
- RESULTS IN MICROGRAMS PER GRAM DRY WEIGHT (EXCEPT AS NOTED).
- RSD = RELATIVE STANDARD DEVIATION (1 SIGMA), IN PER CENT.
- EXTRA SIGNIFICANT FIGURES ARE QUOTED. ROUND RESULTS IN ACCORDANCE WITH OUR ESTIMATE OF THE INDIVIDUAL RSD.

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NEUTRON ACTIVATION ANALYSIS REPORT — 31-JAN-86
FOR : CCRMP - CANMET
SAMPLE : OKA-2 2 — MOISTURE CONTENT = 0.3 %

ELEMENT	CONTENT	RSD, %
POTASSIUM(%)	< 1.20	
SCANDIUM	31.3	6.1
SODIUM (%)	0.350	7.7
THORIUM	2.630E+04	3.0
URANIUM	234.	13.9

ELEMENT	CONTENT	RSD, %
RARE EARTHS :		
CERIUM	1.170E+05	3.0
DYSPROSIUM	2.610E+03	8.6
ERBIUM	< 810.	
EUROPIUM	1.930E+03	3.0
GADOLINIUM	3.900E+03	32.1
HOLMIUM	159.	7.9
LANTHANUM	4.700E+04	3.0
LUTETIUM	< 7.70	
NEODYMIUM	5.420E+04	3.1
PRASEODYMIUM	1.120E+04	9.2
SAMARIUM	8.330E+03	3.0
TERBIUM	474.	4.0
THULIUM	150.	20.6
YTTERBIUM	97.0	18.1

NOTES :
- RESULTS IN MICROGRAMS PER GRAM DRY WEIGHT (EXCEPT AS NOTED).
- RSD = RELATIVE STANDARD DEVIATION (1 SIGMA), IN PER CENT.
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NEUTRON ACTIVATION ANALYSIS REPORT 31-JAN-86
FOR : CCRMP - CANMET
SAMPLE : DKA-2 3 MOISTURE CONTENT = 0.3 %

ELEMENT	CONTENT	RSD, %	ELEMENT	CONTENT	RSD, %
POTASSIUM(%)	< 0.640				
SCANDIUM	27.4	4.2	RARE EARTHS :		
SODIUM (%)	0.319	5.1			
THORIUM	2.530E+04	3.0	CERIUM	1.060E+05	3.0
URANIUM	236.	14.1	DYSPROSIUM	2.780E+03	5.3
			ERBIUM	< 440.	
			EUROPIUM	1.720E+03	3.0
			GADOLINIUM	3.750E+03	19.7
			HOLMIUM	155.	7.6
			LANTHANUM	4.810E+04	3.0
			LUTETIUM	< 3.90	
			NEODYMIUM	4.990E+04	3.1
			PRASEODYMIUM	1.100E+04	10.1
			SAMARIUM	8.070E+03	3.0
			TERBIUM	451.	3.3
			THULIUM	124.	16.7
			YTTERBIUM	170.	11.2

NOTES : - RESULTS IN MICROGRAMS PER GRAM DRY WEIGHT (EXCEPT AS NOTED).
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NEUTRON ACTIVATION ANALYSIS REPORT — 31-JAN-86
FOR : CCRMP - CANMET
SAMPLE : OKA-2 4 — MOISTURE CONTENT = 0.3 %

ELEMENT	CONTENT	RSD, %	ELEMENT	CONTENT	RSD, %
POTASSIUM(%)	< 0.830				
SCANDIUM	30.9	6.0	RARE EARTHS :		
SODIUM (%)	0.345	5.8			
THORIUM	2.600E+04	3.0	CERIUM	1.140E+05	3.0
URANIUM	238.	15.6	DYSPROSIUM	2.970E+03	6.4
			ERBIUM	< 570.	
			EUROPIUM	1.800E+03	3.0
			GADOLINIUM	4.910E+03	19.6
			HOLMIUM	205.	7.0
			LANTHANUM	4.790E+04	3.0
			LUTETIUM	< 7.50	
			NEODYMIUM	5.440E+04	3.1
			PRASEODYMIUM	1.100E+04	10.2
			SAMARIUM	8.730E+03	3.0
			TERBIUM	472.	4.0
			THULIUM	140.	20.9
			YTTERBIUM	140.	13.8

NOTES : - RESULTS IN MICROGRAMS PER GRAM DRY WEIGHT (EXCEPT AS NOTED).
- RSD = RELATIVE STANDARD DEVIATION (1 SIGMA), IN PER CENT.
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NEUTRON ACTIVATION ANALYSIS REPORT — 31-JAN-86
FOR : CCRMP - CANMET
SAMPLE : OKA-2 5

MOISTURE CONTENT = 0.3 %

ELEMENT	CONTENT	RSD, %
POTASSIUM(%)	< 0.830	
SCANDIUM	27.1	4.8
SODIUM (%)	0.320	4.1
THORIUM	2.380E+04	3.0
URANIUM	214.	12.8

ELEMENT	CONTENT	RSD, %
RARE EARTHS :		
CERIUM	1.010E+05	3.0
DYSPROSIUM	2.850E+03	4.6
ERBIUM	< 300.	
EUROPIUM	1.630E+03	3.0
GADOLINIUM	3.830E+03	13.0
HOLMIUM	154.	7.5
LANTHANUM	4.710E+04	3.0
LUTETIUM	< 4.80	
NEODYMIUM	4.950E+04	3.1
PRASEODYMIUM	1.140E+04	8.6
SAMARIUM	8.110E+03	3.0
TERBIUM	443.	3.5
THULIUM	141.	17.3
YTTERBIUM	150.	11.1

NOTES :
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BECQUEREL LABORATORIES INC.

ANALYSIS CERTIFICATE

THORIUM NATURAL DECAY SERIES

BATCH ID : CANMET CCRMP

SAMPLE : OKA-2 Bottle #432

NUCLIDE	NOTE		RESULTS , (BQ/G)	(1 RSD)
THORIUM-232	*	.....	104	(3.0)
RADIUM-228	1	.....	( )	
ACTINIUM-228	*	.....	109.	(1.0%)
THORIUM-228	2	.....	(110)	
RADIUM-224	2	.....	(110)	
RADON-220	2	.....	(110)	
POLONIUM-216	2	.....	(110)	
LEAD-212	*	.....	110.	(0.3%)
BISMUTH-212	*	.....	108.	(1.5%)
POLONIUM-212	2	.....	(107)	
THALLIUM-208	*	.....	41.5	(0.6%)

NOTES : * = DIRECT MEASUREMENT.

1 = INFERRED FROM AC-228.

2 = INFERRED FROM PB-212.

ANALYST : D.C. Stuart

Th-232 = 2.6% by NAA

= 2.7% by Pb-212 count

BECQUEREL LABORATORIES INC.

ANALYSIS CERTIFICATE

URANIUM NATURAL DECAY SERIES

BATCH ID : CANMET CCRMP

SAMPLE : CKA-2 Bottle #432

NUCLIDE	NOTE	RESULTS , (BQ/G)	(1RSD)
URANIUM-238	*	2.8	(15%)
THORIUM-234	*	2.9	(20.7%)
PROTACTINIUM-234M	1	(2.9)	
PROTACTINIUM-234	1	(illegible)	
URANIUM-234	2		
THORIUM-230	*	< 12.	
RADIUM-226	3	(2.76)	
RADON-222	3	(2.76)	
POLONIUM-218	3	(2.76)	
ASTATINE-218	3	(0.00055)	
LEAD-214	*	2.76	(5.%)
BISMUTH-214	*	2.6	(7.%)
POLONIUM-214	3	(2.7)	
THALLIUM-210	3	(0.00057)	
LEAD-210	*	2.5	(42%)
BISMUTH-210	4	(2.5)	
POLONIUM-210	5	(2.5)	
THALLIUM-206	4	(0.00033)	

NOTES :

* = DIRECT MEASUREMENT.

1 = INFERRED FROM TH-234 MEASUREMENT.

2 = INFERRED FROM U-238 (ASSUMES NO ISOTOPIC SEPARATION).

3 = INFERRED FROM PB-214 / BI-214 (ASSUMES RN-222 AT EQUILIBRIUM AND SEALED).

4 = INFERRED FROM PB-210 MEASUREMENT.

5 = INFERRED FROM PB-210 MEASUREMENT (ASSUMES EQUILIBRIUM WITH PB-210).

4 = 230 ppm by NAA
= 219 ppm by Pb-214 count

ANALYST : D.C. Stuart.